Naval Weapons Station Earle
Southern Pine Beetle Biological Evaluation

Prepared By: Christopher Hayes
Entomologist

USDA Forest Service
Northeastern Area State and Private Forestry
Forest Health Protection
180 Canfield Street
Morgantown, WV 26505
December, 2016

Table of Contents

Abstract

Since 2009, southern pine beetle (SPB), *Dendroctonus frontalis* Zimmermann (Coleoptera: Curculionidae), has been found causing pine mortality throughout the Pine Barrens region of New Jersey. In 2015, aerial surveys detected SPB-caused tree mortality approximately 14 miles from Naval Weapons Station Earle (NWSE). Considering the recent increased activity of SPB in New Jersey and the presence of extensive stands of a preferred host species, pitch pine, *Pinus rigida*, NWSE requested a biological evaluation of the risk of SPB-caused tree mortality and management recommendations for how to prevent high levels of tree mortality due to this aggressive, tree-killing insect. This hazard analysis found 43% of forest stands are low risk for SPB mortality, while 57% are either medium or high hazard for SPB mortality. Twelve percent of all stands are high hazard for SPB-caused mortality. High hazard stands on NWSE are predominately pitch pine with a basal area greater than 120 ft^2 per acre. Bottomland stands with high stocking and a large pine component also have elevated SPB hazard. Management recommendations include preventative thinning treatments, suppression measures, and chemical treatments. We recommend NWSE create a management plan that includes preventative management, monitoring, and suppression activities.

Purpose and Need

The Forest Health Protection unit of the U.S. Forest Service, Northeastern Area, State and Private Forestry Field Office (MFO) in Morgantown, WV, received a request in the summer of 2016 from NWSE to visit and assess an area of bark beetle tree mortality. A field visit was conducted on July 12, 2016, at which time NWSE requested a biological evaluation of SPB hazard and management recommendations. NWSE had recently contracted field crews that gathered stand data which NWSE agreed to share for this analysis. As SPB has been active and killing trees just south of NWSE this biological evaluation will be important information for the development of a management plan for SPB at NWSE.

Project Location/Description

Naval Weapons Station Earle, located in Monmouth County, New Jersey, is a naval weapons storage area. It consists of two main areas, the 'Mainside' is located in Colts Neck, NJ, and the 'Waterfront' is in the Leonardo section of Middletown. The two areas are connected by a private, federally-owned roadway. Colts Neck sits in the heart of New Jersey's horse farming region and Leonardo is located on Sandy Hook Bay overlooking the Atlantic Ocean and the New York City skyline. The 'Mainside' section of the station includes natural pitch pine habitats typical of the Pine Barrens region of New Jersey and includes approximately 7,500 acres of forested lands. Although the Mainside section function is munitions storage, the land is mainly forested and managed as a natural area by the station and has a variety of habitat types and a high diversity of tree species.

NWSE has a wide variety of deciduous tree species, some associated with Southern deciduous forest and some with Northern forests. Trees species found that are associated with Southern forests are sweetgum, black tupelo, and tulip poplar. A large number of oak occur on NWSE, including white, black, Northern red, post, pin, chestnut, blackjack, willow, and scarlet oak, and taken together are the most commonly found type of trees on NWSE. Other hardwoods include red maple, sassafras, black cherry, black locust, common persimmon, American holy, American beech, sweet birch, and slippery elm. In addition to the large pitch pine component, small amounts of shortleaf, loblolly, Scotch, and Eastern

white pine can also be found. Other conifers found on NWSE include Eastern larch, Norway spruce, and Atlantic white cedar. Topography is varied and ranges from dry, well-drained hills to wet bottomlands.

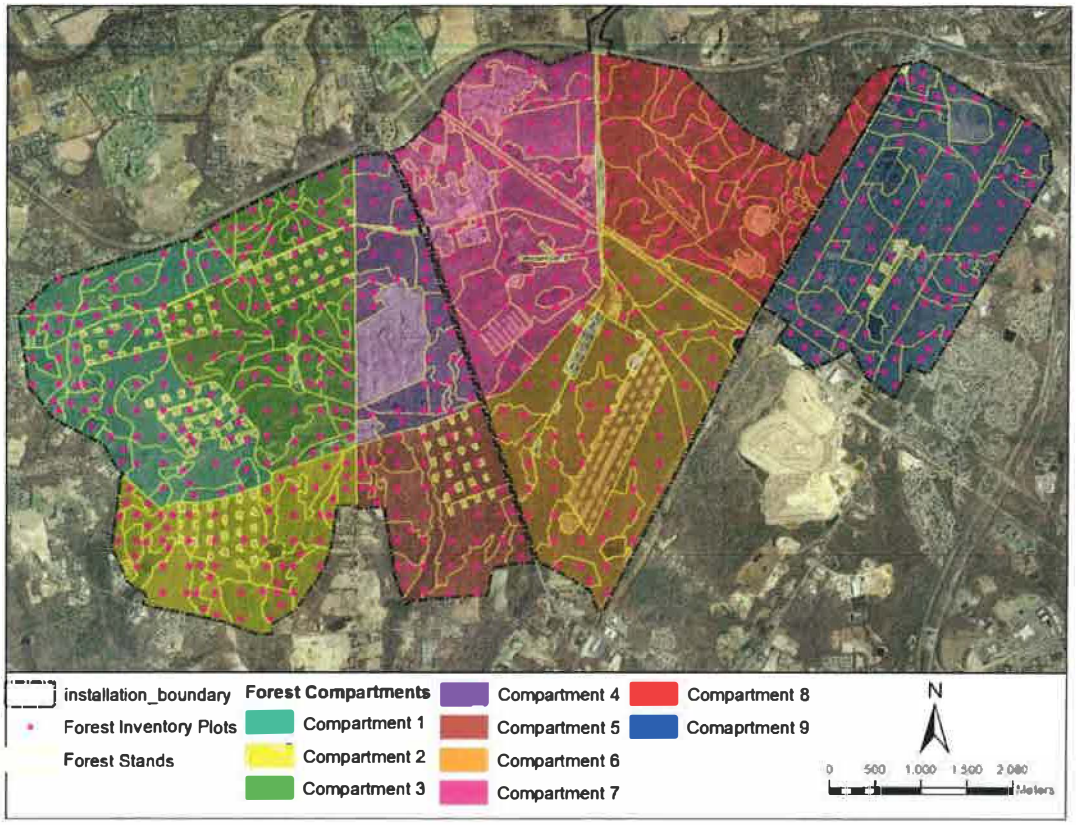

Figure 1 Naval Weapons Station Earle, Colts Neck, NJ, 'Mainside' divided into compartments and forest stands. Pink dots represent forest inventory plots.

Species Evaluation/Background

Insect Life Cycle

The SPB has a complete metamorphosis life cycle and must cause pine tree mortality to complete its life cycle. Complete metamorphosis consists of the egg, larval, pupal, and adult life stages. The egg, larva, and pupal stages of SPB are spent in the inner bark of pine trees and during the final life stage, the adult, it leaves the host tree in search of a new live host tree to attack and reproduce. Successful colonization and subsequent tree mortality is accomplished through the use of pheromone attractants and mass attacking behavior. Once a female SPB adult successfully attacks a tree she emits pheromones that attract other individuals. If sufficient numbers of SPB attack a tree over a short period of time the beetles will overwhelm the tree's defenses and kill the tree through a combination of girdling, thereby cutting of the function of the phloem, and

Figure 2. SPB on a fresh 'pitch-tube'. As beetles develop their galleries further pitch-tube turns reddish as frass is ejected.

through the introduction of blue stain fungus, a wilt fungus that disrupts water transport through the xylem cells of the tree. SPB have 2-8 generations per year depending on the local climate (Thatcher 1960), with populations in the northern areas of this insects range experiencing two to three generations per year due to fewer warm days per year—in years with exceptionally warm spring and/or fall SPB can continue their development and have an additional generation.

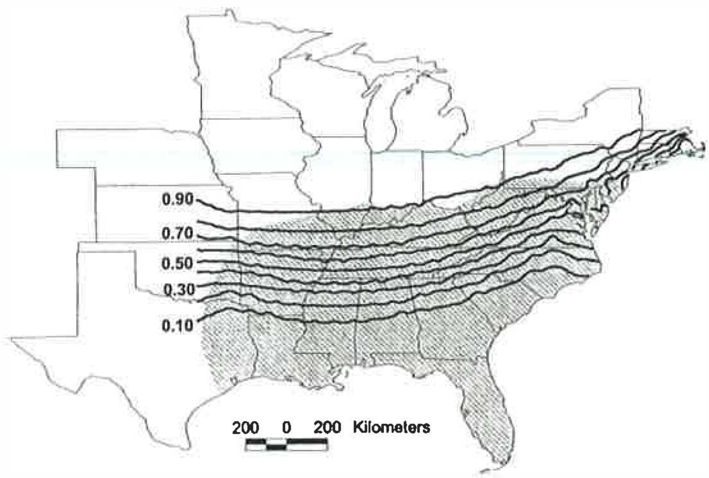

Figure 3 Annual probability of reaching the lower lethal temperature for the southern pine beetle, Dendroctonus frontalis (≈-16°C air temperature). Maximum recorded D. frontalis distribution is shown as the shaded area. The northern limits for economically meaningful outbreaks is ≈300 km farther south, where the annual probability of winter mortality is ≈0.5. From Ungerer et al. (1999).

SPB are cold sensitive and mortality due to cold winter temperatures is an important factor in constraining their northern distribution (Swaine 1925). The temperature at which SPB start to experience mortality is -12 °C (10.4 °F) and the temperature at which complete mortality due to cold is -16 °C (3.2 °F)(Ungerer et al. 1999). This is important as NWSE is at the northern edge of the SPB geographical range and these cold temperatures likely dictate the edge of that range and can be an important driver in population dynamics in this area. That is, an exceptionally cold winter (numerous days with temperatures lower than -16 °C) in this area will likely cause mortality of overwintering SPB.

Type of Damage

SPB is an aggressive tree-killing insect. With spring flight timing dependent on latitude and local climate, overwintering individuals make a dispersal flight in search of a live pine tree to attack and colonize. Once one tree is successfully attacked—they typically choose lightning struck trees, especially when beetle populations are low or trees are not experiencing stress from competition for resources—a spot infestation is started. Successive attacks of beetles that overwintered in the egg or larval stage and initiated dispersal flight later than the overwintering adults and successive generations attack trees adjacent to the initial attacked tree. These successive generations continue to kill nearby trees, expanding the "spot" of SPB-killed trees. These "spots" can range from several acres to several thousand acres.

Figure 4. SPB spot with older dead SPB-killed trees to the right and newly attacked trees on the left.

Objectives

The objectives for this evaluation were to 1) determine whether or not SPB was present at NWSE in summer of 2016, 2) assess the SPB hazard

(suitability of stands to support SPB infestations) of NWSE forests, and 3) to provide management recommendations for minimizing associated impacts.

Methods

In order to help NWSE develop a SPB management plan that is tailored to the current conditions of their forested areas, I conducted a hazard analysis using forest inventory data recently obtained by NWSE. The inventory included plot data from 191 individual stands. With this data I conducted an analysis and was able to assign a hazard score. My methods for designating SPB hazard are described below.

SPB Hazard Rating

To give land manages an idea of what stand conditions are more prone to high SPB-caused mortality and prioritize areas for treatment, researchers have developed tools for rating the hazard (or probability) of a stand experiencing extensive SPB-caused mortality. There have been a number of hazard rating systems created that use stand level data to predict the probability of a stand suffering SPB-caused mortality (Daniels et al. 1979, Hedden and Belanger 1985, Ku et al. 1980). Most of these models use some measure of tree vigor (typically measured through basal area or radial tree growth), landform, and soil characteristics (Brit 2011). These models attempted to give a probability of beetle outbreak and often included the measure diameter growth increment which requires a tree core—a measurement not every forest owner is going to be able to obtain. Aside from attempting to produce a specific probability, these models proved instructive as to what variables were important to our understanding of the relationship between SPB and forest stands and the success of SPB in killing trees.

Although none of these hazard rating models were developed with data from the Mid-Atlantic States, there have been investigations that separated analyses by landscape-level geographical types—NWSE could be characterized as being located in a coastal plain. Coster and Searcy (1981) divided SPB habitat into *coastal flood plains, piedmont,* and *Appalachian Mountains.* In coastal plains, SPB outbreaks were found to be more common in wet, low-lying sites with high stocking levels (basal area) (Coster and Searcy 1974; Belanger and Malac 1980). Stand age and tree diameter are associated with SPB-caused mortality; older stands are associated with SPB while young, small diameter stands typically don't experience much SPB-caused mortality. Hedden (1983) found that shortening rotation age reduced losses due to SPB, likely due to lower stand basal area and high vigor associated with young trees. Finally, host tree presence is associated with hazard, as host trees are required SPB habitat.

Many hazard rating systems have tried to assign a probability of whether a stand would be attacked. That is not the objective of this analysis, however. My goal in this analysis is to identify areas that are more likely to support SPB outbreaks. It will be difficult to determine how likely to be attacked by SPB particular areas of NWSE will be. However, in this analysis areas of high hazard are perfect breeding grounds for bark beetles because of the high numbers of acceptable host trees experiencing high levels of competitive stress due to harsh climate conditions, poor site conditions, and/or high stand stocking. When SPB are at epidemic population levels these stands become vulnerable to attacks and can be expected to experience high levels of SPB-caused mortality. For this analysis, I chose to modify existing hazard rating systems to New Jersey conditions by adjusting existing models with local knowledge of SPB behavior.

Table 1. Factors used for assessing the SPB risk for individual forest stands and the points assigned to each level of these factors. Each stand was assigned a score for each of these four factors and the four scores were summed for a score on a scale of 0-6 (0-2=low, 3-4=medium, and 5-6=high risk).

Factors	Levels	Risk-rating points
Stand basal area (ft^2/ac)	less than 80 (low density)	0
	80 to 120 (medium density)	1
	more than 120 (high density)	2
Stand class by average dbh (in inches)	pulpwood (9 inches or less)	0
	sawtimber (more than 9 inches)	1
Percent of BA pine	<10%	0
	10-50%	1
	>50%	2
Bottomland	Not bottomland	0
	Bottomland	1

The hazard rating system used here utilizes four factors known to influence SPB hazard: stand density, tree diameter, percent pine, and bottomland location. Stand density has been positively correlated with hazard, with stands with 120 and greater square feet per acre of basal area considered at high hazard for supporting SPB outbreaks (Klepzig et al. 2003). Tree diameter is also thought to be important in SPB hazard, with small-timber stands (typically defined as mean diameter of 9-12 inched dbh) and larger being at a higher risk to SPB outbreak than pole-sized (mean diameter less than 9 inches dbh) stands. Percent pine is used to indicate that there are sufficient host trees in a stand to make SPB a concern, as SPB requires hosts trees to reproduce. And finally, bottomland sites with their high water table have been identified as sites with increased risk for SPB-caused mortality. In this model the highest hazard stand would be a pure pitch pine, bottomland stand of greater than 120 square feet of basal area and an average tree diameter greater than 9 inches dbh. All stands with 10% or less pine by basal area were considered low hazard regardless of overall score due to their lack of SPB host. Stands were assigned scores of 0-6 per the rating system described in Table 1 by assigning a score for each factor and combining the four scores, with 0-2 equaling low risk, 3-4 medium risk, and 5-6 high risk. Data from a recent forest inventory of NWSE was used in this analysis.

Table 2. Summary table of stand classifications, percent host (pine), stand density, and predominance of each stand type found at NWSE by recent contracted forest inventory, 2016.

Stand Forest Type	Number of Stands	Mean % Pine	Mean Basal Area (ft^2/ac)	Sum of Stand Area (ac)	% Land Area
Xeric mixed pine-hardwoods	40	42	104	1726	23.0
Oak-northern pine	25	52	92	1069	14.2
Oak	21	3	92	868	11.5
Oak-bottomland hardwoods	15	6	104	527	7.0
Southern bottomland hardwoods	11	7	116	501	6.7
Bay-swamp pocosin	14	10	106	499	6.6
Oak-northern hardwoods	12	9	93	438	5.8
Pine-hardwoods	9	53	102	429	5.7
Pitch pine (pure)	16	92	107	421	5.6
Plantation pine (Eastern white pine)	4	83	127	259	3.4
Xeric mixed southern pine	5	71	127	191	2.5
Bottomland mixed	3	45	181	149	2.0
Xeric mixed hardwood-pine	1	11	105	111	1.5
Chestnut oak (pure)	2	5	77	110	1.5
Pine	3	80	119	72	1.0
Oak-southern pine	1	25	93	41	0.6
Bottomland hardwoods	2	0	60	30	0.4
Bottomland conifer	1	2	160	26	0.3
Mixed hardwood-black cherry	1	4	140	18	0.2
Atlantic white cedar (pure)	3	0	241	13	0.2
Scarlet oak (pure)	1	11	90	10	0.1
Oak northern-pine	1	71	70	9	0.1
Grand Total (% pine and BA are mean)	191	34.5	105	7519	100.0

Results

SPB host trees, consisting mainly of naturally occurring pitch pine and limited amounts of shortleaf pine and planted eastern white pine, are an important forest component at NWSE; 57.5% of all forest stands have greater than 30% pine by basal area (Table 2). Around one third (33.6%) of all forested land area

on NWSE has either no pines or a relatively small number of pines (<10%), giving these stands little to no SPB hazard. Overall, 43% of NWSE forest stands are low risk for SPB mortality, while 57% are either medium or high hazard for SPB mortality (Figure 5; 45% medium risk, 12% high risk).

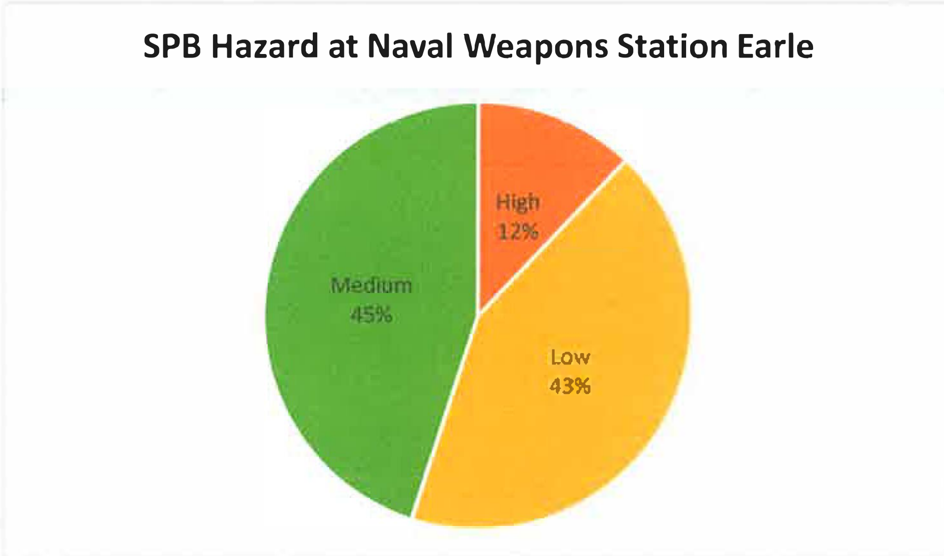

Figure 5. Percentage of all stands at Naval Weapons Station Earle, Colts Neck, NJ (excluding compartment 10), in each of three southern pine beetle hazard categories, 2016.

Two stand types of special consideration are pine-dominated stands with high stocking levels and bottomland stands. Highly-stocked pine dominated stands are of primary concern for SPB management. When conditions favor SBP—low SPB predator population levels and tree defenses lowered by drought, for example—this type of stand is most likely to experience high levels of SPB-caused tree mortality and allow for high levels of SPB brood survival that are likely to sustain an outbreak. Bottomland stands, by contrast, do not appear to need specific conditions to sustain SPB populations. Recent mortality patterns in NJ bottomland stands are sustained and steady. The typical pattern of mortality in bottomland stands usually consists of small clumps of mortality that grow slowly year after year regardless of other conditions (personal observation). It appears that the high water tables in these stands acts as a consistent stressor for pines, thus tipping the balance for factors influencing SPB population levels in favor of the SPB.

Slightly less than one quarter of NWSE is bottomland (Table 4; 43 out of 191 stands). Of the bottomland stands, five scored as high risk for SPB, which accounted for 2.8% of all forested land area at NWSE, and 39.5% of these stands has no pine at all and will not support SPB. Table 3 lists bottomland stands with pines that should be monitored for SPB activity. To see specific stand information and hazard ratings see Appendix A and B.

Table 3. Bottomland stands that should be carefully monitored for SPB activity and considered for treatment.

Compartment	Bottomland Stands	Acres
1	5, 17, 23	167
2	2	8
3	5, 9, 11	75
4	3	24
5	4	76
6	--	0
7	7, 25	84
8	2, 4, 6, 7, 9, 10, 14, 16	360
9	18	63
	Total Acres	**857**

Table 4. The number of stands and total acres of stands defined as bottomland separated by southern pine beetle hazard rating at Naval Weapons Station Earle, Colts Neck, NJ.

Bottomland Stand Type by SPB Hazard Rating	Number of Stands*	Total Acres*
Bay-swamp pocosin	—	—
High	0	0
Medium	6 (3.1%)	204 (1.4%)
Low	8 (4.2%)	295 (3.9%)
Bottomland mixed	—	—
High	2 (1%)	80.7 (1.1%)
Medium	1 (0.5%)	68.1 (0.9%)
Low	0	0
Oak bottomland hardwoods	—	—
High	0	0
Medium	5 (2.6%)	179 (2.4%)
Low	10 (5.2%)	319 (4.2%)
Southern bottomland hardwoods	—	—
High	3 (1.6%)	135.5 (1.8%)
Medium	2 (1%)	159.8 (2.1%)
Low	6 (3.1%)	206 (2.7%)
Total Bottomland	43(22.5%)	1,647 (21.9%)
Naval Weapons Station Total	191	7,519

*percentage of total land area in NWSE in parenthesis.

Discussion

NWSE is in many ways fortunate. Although there are many stands that currently have the potential to experience high levels of SPB-caused pine mortality, NWSE is in relatively good shape when it comes to SPB hazard, with close to half of all forested lands having low SPB hazard. There are two main factors that benefit NWSE—stand diversity and stand age. A very bad situation would consist of large tracts of mature, overstocked pine. By contrast, NWSE has numerous stand types, and these stand types have pine components that range from zero to 100% pine. Also, the landscape surrounding NWSE is diverse, with most adjacent property consisting of suburban lands that do not contain prime SPB habitat (Figure 7; https://foresthealth.fs.usda.gov/nidrm/). Also, the U.S. Forest Service has estimated that Monmouth County has less than 10% of land area with a moderate or high SPB hazard (based on U.S. Forest Service 2012 National Insect and Disease Risk Map, estimating hazard over a 15 year period, 2013-2027).

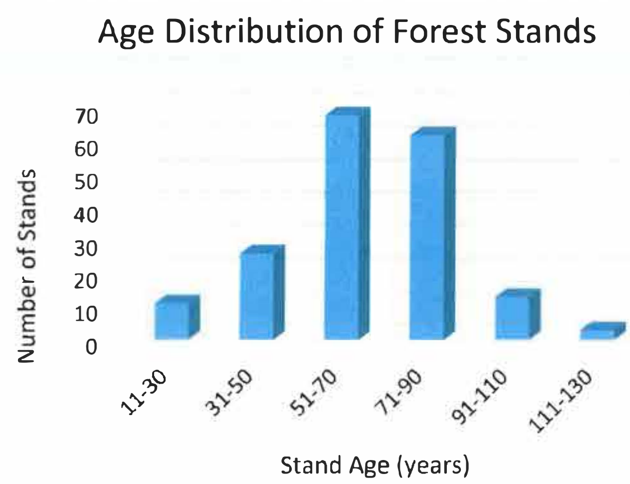

Figure 6. Age distribution of stands at NWSE.

Another important factor is stand age; many of the stands are relatively young. The mean stand age is 66 year (Figure 6) and, although most stands are not extremely young, there is still an opportunity to manage these forests before competition amongst trees becomes high, making them more vulnerable to SPB and other disturbance agents. In the coming decades, as stands develop further and trees become larger, competition will increase and tree mortality will increase as part of the natural stand development process.

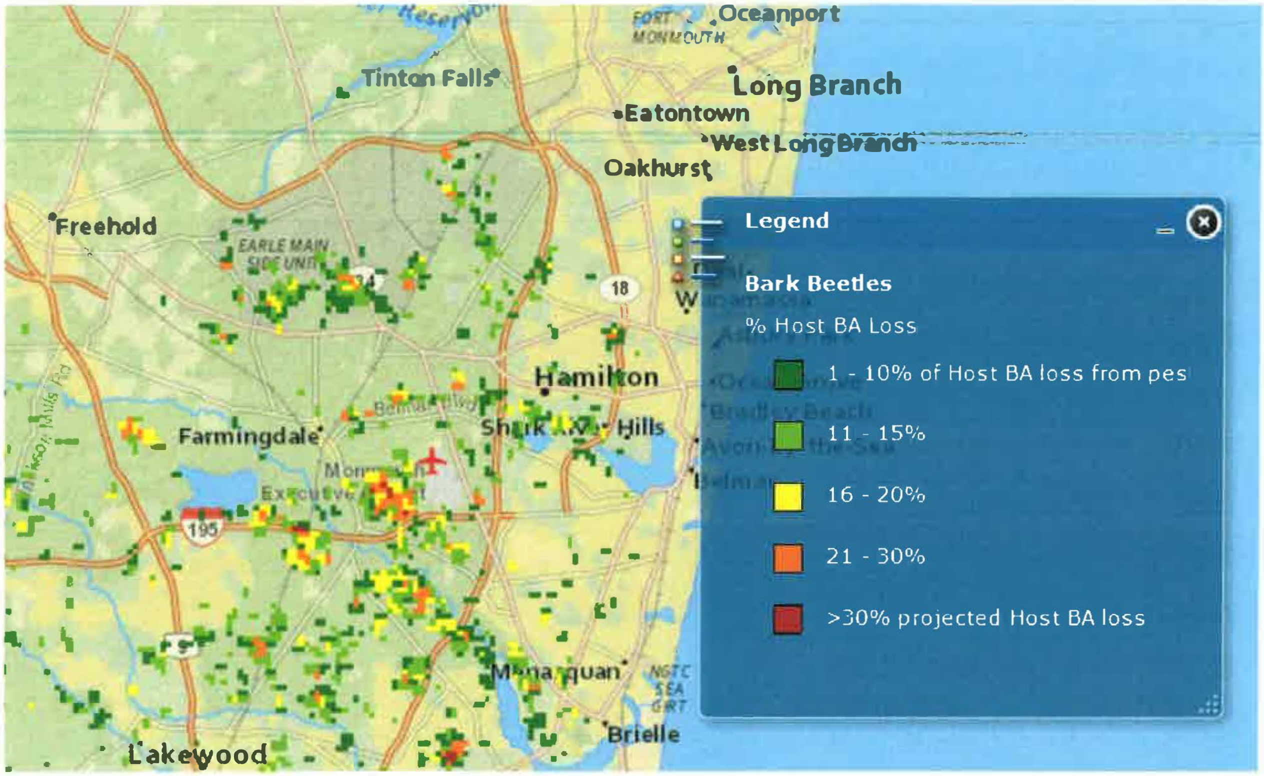

Figure 7. Southern pine beetle hazard map developed with current forest cover knowledge and mortality models by USDA Forest Service for estimating probable tree losses due to various insects, 2013-2027 National Insect and Disease Risk Map Viewer

Treatments and Management Alternatives

There are many treatment options for the control of SPB and one, or a combination of treatments, can be utilized for different management alternatives, both short term and long term. Long-term SPB management activities typically involve silviculture and stand management and often involve limiting stand density to reduce tree competition. Short-term management options are more varied and include cut-and-leave, pile-and-burn, and chemical control to name a few. Depending on your management objectives you may choose to use a variety of these techniques or none at all. Whatever your decision, we encourage you to identify your objectives and write a plan for how you are going to work to meet those objectives.

Treatment 1 – Cut-and-Remove. In cut-and-remove (also called Salvage Removal) all infested trees and a buffer of healthy trees are felled and then removed from the site to be utilized as wood products or otherwise disposed (e.g., landfill, burn pit, chipper, etc.). Because beetles are removed from the site, this tactic is very effective. However, cut-and-remove may not be feasible due to a lack of local timber markets. Cutting infested trees followed by chipping on site is an alternative variation of this management option that functions as a means for killing SPB brood trees and simultaneously reduces the long-term fire hazard in a stand. Cutting a buffer area is especially important in growing season cut-and-remove activities, as the buffer creates a gap between any freshly attacked trees that may be emanating pheromones and living, un-infested pines. Buffer width may vary based on size of an infestation, but should be 60–125 ft. wide or at least equal to one tree height.

Treatment 2 – Cut-and-Leave. The cut-and-leave method involves directionally felling currently infested and buffer trees toward the center of an infestation to disrupt SPB spot infestation growth. In an active spot, trees can be classified into three stages: Stage 1, fresh SPB attacks with crown still green; Stage 2, brood trees, tree crown is turning from green to orange and exit holes are not yet seen; and Stage 3, vacated trees, exit holes can be found, bark is loose, and red crown with needles starting to drop or needles completely off trees. Stage 3 trees do not have to be felled. Stage 1 and Stage 2 trees are felled back towards the points of initial spot development and a buffer of green, healthy trees are cut at the advancing edge (Figure 8). The width of the buffer should be at least equal to the height of the trees being felled, up to a distance equal to twice the height of the trees being felled. Although it does not kill all SPB brood in a spot, felling currently infested trees can have a negative effect on developing SPB brood, with brood survival depending on cutting timing and treatment of logs (Hodges and Thatcher 1976). Cut-and-leave also disrupts pheromone plumes and beetle communication within an infestation. Trees are generally left on the ground at a site, and if tree bolts are left with high sun exposure, solar radiation will kill a portion of the brood in trees felled during cut-and-leave in the summer. Some beetles, however, will survive and disperse from downed trees. Trees felled after the growing season should be cut as early as possible in the winter, with care taken to make sure felled trees are on the ground.

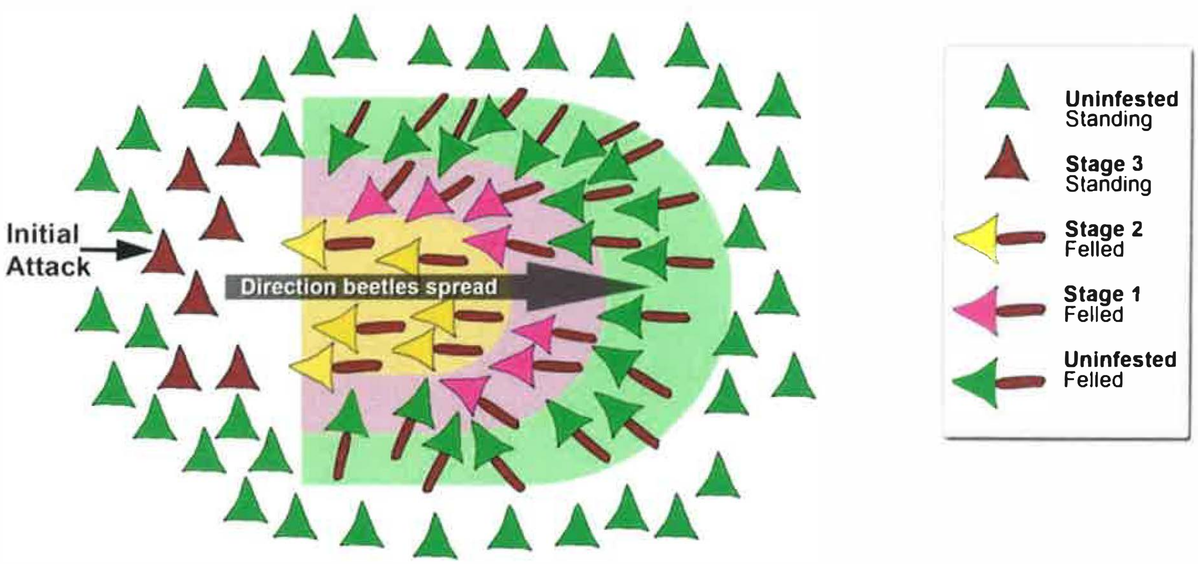

Figure 8. This diagram illustrates the 'cut-and-leave' method of suppressing SPB 'spots". The Stage 3 trees indicate where the initial attack started. The arrow indicates the direction the infestation was spreading.

While cut-and-leave will result in some beetle mortality, these trees will likely still be a source of SPB. Consequently, it is important to follow up any cut-and-leave operation with surveys to ensure the infestation has been eliminated. Cut-and-leave is not appropriate for all situations and is most effective with smaller spots (<100 infested trees) (Clarke and Nowak, 2009). When cut-and-leave is used it is important to consider the at-risk forest in the surrounding areas. If there are other active infestations in close proximity to the targeted infestation, every effort should be taken to also suppress those additional spots.

Treatment 3 – Pile-and-Burn. Felling, piling, and thoroughly burning the bark of infested trees is another method of controlling SPB. The entire bark surface must be thoroughly burned to insure beetle

mortality and cutting a buffer strip is not recommended. Every effort should be made to locate and treat all green infested trees during the piling and burning operation to help avoid additional SPB-caused tree mortality. It is important to burn the pile prior to SPB brood exiting the logs. This method may be easiest to do in winter months if brood trees with overwintering beetles can be identified. In addition to the fire hazard this treatment presents, care should be taken to not burn piles to hot, as this can result in soil erosion or the creation of ideal soil conditions for exotic, invasive plants to become establish.

For the cut-and-burn, and cut-and-leave treatments, post-suppression monitoring of growing season treated stands should be conducted at least twice in the two months following cutting activities. The first stand survey should be conducted one to two weeks after suppression activities are complete, and all residual pines surrounding the cut infestation should be checked for signs of SPB attack. Any trees found to be attacked should be cut immediately and efforts taken to disrupt the phloem-bark interface—bark scoring can kill attacking beetles and reduce the area of SPB habitat. The second survey should occur 40-50 days after suppression activities are complete. For suppression activities that occur during the winter, trees surrounding the treated area should be checked for fresh attacks early in the spring, and if trees are found to be attacked, they should also be cut as quickly as possible.

Treatment 4 – Chemical control. High-value trees can be protected from attack with preventative insecticide bark sprays, which contain permethrin or bifenthrin and are labeled for such use and are applied to the trunk of the tree. Trunk injections containing emamectin benzoate are also recommended and provide systemic protection from SPB when applied at least one month prior to spring SPB emergence. The choice of whether to treat chemically or not should be done on a case-by-case basis with concerns for possible impacts on non-target insects. When applying trunk sprays precautions to avoid drift should also be taken. This type of treatment is usually recommended for urban or residential settings, or in the case of NWSE, at developed areas (for example, around housing and other developed areas). Consult New Jersey Department of Environmental Protection for registration information for specific products. Also, most insecticides used for the control of bark beetles are restricted use and require a certified applicators license to apply. Consult the product label for this information.

Treatment 5 – Thinning, and Thin-and-Burn. Pine trees have natural defenses that can repel SPB attacks, especially when SPB population levels are low. SPB-attacked pine trees exude pitch that serves to "pitch-out" the beetles. Stand density is highly related to tree vigor and, subsequently, tree defenses. Because thinning reduces tree competition and increases individual tree vigor and thereby reduces the chance of SPB-caused tree mortality, it has become the prominent long-term management tool for SPB management. Pine stands (or stand with a large pine component) with total basal area of greater than 120 ft^2 of basal area per acre are considered to be at high risk for SPB infestations and it is recommended that these stands be thinned (Klepzig et al. 2003). Thinning level targets for reduced SPB hazard vary from 70-100 ft^2 of basal area. Belanger and others (1993) report very low probability of spot growth at 70 ft^2 of basal area, while others found thinning to levels less than 100 ft^2 of basal area sufficient to reduce SPB susceptibility (Burkhart et al. 1986, Hedden 1978). While the upper basal area target of 100 ft^2 may suffice, it is important to remember that you are buying yourself more time if you thin to lower levels as heavily thinned stands will take longer to grow back to high hazard levels. Also, wide tree spacing is thought to hamper SPB attack activity and spacing between trees of 18 feet and up to 20-25 feet has been recommended (Gara and Coster 1968).

Prescribed fire has been used in the Pine Barrens region to reduce ground fuels but little is known about the relationship between prescribed fire and SPB. Excessive crown scorch should probably be avoided, however, as scorch and increased bark beetle susceptibility has been documented in other bark beetle systems (McHugh et al. 2003). In general, it is thought that prescribed fire does not exacerbate SPB activity as long as damages to 'leave' trees are kept to a minimum.

Thinning pine stands not only reduces SPB hazard, but it also causes 'leave' trees to grow faster in diameter and reduces wildfire hazard. Because of the multiple benefits of this treatment, it is highly recommended.

Selection of one or several of these treatment strategies is possible for the control of SPB infestations. Below are treatment alternatives that, considering current NWSE forest conditions, I think NWSE should consider.

Alternative 1 – No Action. There are many reasons a no action alternative may be chosen, including potential negative impacts on threatened and endangered species, cost limitations, or management philosophy (e.g., wilderness designation). At present there are low, endemic SPB populations at NWSE that have yet to cause visible tree mortality (monitoring traps caught small numbers of SPB in 2016). With no action, it can be expected that NWSE will begin to see SPB-caused mortality in the coming years. Mortality patterns observed in nearby areas in recent years have been characterized by slow, ongoing spot growth in bottomland stands and occasional spot development in upland areas when conditions (e.g., low SPB predator populations, and drought) are favorable to SPB. These areas of mortality, or spots, are not showing the characteristics of rapid spot growth found in the southern part of the SPB range, but rather are growing more slowly and continuing to spread over many years regardless of inter-annual conditions, especially in stands with very high water tables.

Under this alternative, the beetles can be expected to create tree snags, cause a significant loss of pines in some of the mixed pine/hardwood stands, and also create openings due to SPB-caused mortality in pine dominated stands. Areas of mortality may be from a few acres in size up to 1,000 acres. Mortality levels due to SPB in NWSE under a no action alternative are hard to predict, however, but the lack of active management will lead to more tree loss than the active management alternatives.

Increases in the numbers of snags can have positive benefits, as snags provide nesting sites for some species of cavity-dwelling birds and will provide food, in the form of wood boring insects, for species of snag-foraging birds. In addition, organic matter and nutrients from the dead trees will be returned to the soil.

Reduction in crown cover due to SPB mortality can increase edge habitat, change the availability of nesting sites, and change the characteristics of understory vegetation. These changes have implications on the availability of shelter and cover, as well as the amount and kind of food for wildlife. Leuschner (1980) reviewed the impact of SPB on individual wildlife species and found a positive impact on woodpecker, quail, rabbit, deer, small mammal, and other bird populations, mostly through increases in edge habitat and food.

Standing snags can create a safety hazard, however, as they will eventually fall to the ground. Landowners, parks, highway departments and others may need to consider risks such trees pose to

people, structures, public roads, utilities, etc. NWSE will likely need to remove dead trees next to buildings and munitions storage areas even under a no action alternative.

Alternative 2 – Suppression treatment (Treatments 1-3) only. You may want to employ the cut-and-remove, cut-and-leave, and/or pile-and-burn treatment techniques, reacting to SPB activity after it has developed and you can see signs of eminent tree mortality. This alternative may be attractive because it may require fewer regulatory hurdles; if no live tree buffer is cut then you would essentially just be cutting down dead trees (once needles turn red after SPB attack the tree has no chance of survival). In this option, it is likely that the cut-and-chip method is the most practical and effective. If NWSE has the resources (sawyers, laborers, and a chipper), pine stands could be monitored for faders (mass attacked trees whose needles are changing from green to red) throughout the summer months and SPB-attacked trees could be felled and chipped soon after they were found by NWSE crews.

The cut-and-leave method may also be easily achieved since it requires only skilled sawyers to implement the treatments. This method is most effective when SPB-caused mortality is relatively low and should be closely monitored for additional SPB attacks. Chipping cut trees or removal (timber sale, for example) would be preferable to cut-and-leave.

Alternative 3 – Thinning and suppression treatments. Although much of NWSE is not classified as high hazard, those areas classified as high SPB hazard in this report should be considered for thinning. Stand thinning reduces tree competition and greatly reduces the probability of trees within thinned stands of becoming attacked and killed by SPB. It is important to remember that high-density pine stands offer SPB prime breeding areas in which SPB populations can increase rapidly and cause high levels of tree mortality. If your goal is to limit pine loss due to SPB, these high density pine stands are the greatest impediment to achieving that goal. If suppression treatments are done in addition to thinning of high hazard stands, SPB should have very little chance of causing unacceptable levels of pine mortality on NWSE. Appendix A. lists stands that are good candidates for thinning. Stand 2 in Compartment 2 is a good example of a stand that needs thinning. This stand—being over 75% pine, growing in a bottomland location, and having over 400 trees per acre—is a stand that, once SPB get into a stand with these characteristics, beetle numbers can grow rapidly to hard to manage levels and potentially kill thousands of trees.

Alternative 4 – Thinning, chemical, and suppression treatments. Another treatment option would be to treat some stands to reduce SPB hazard over the long term, monitor NWSE for SPB attacks and conduct suppression activities when trees were attacked, and treat individual, high-value trees when SPB population levels become extremely high. It is not suggested to chemically treat trees just because they may someday be attacked by SPB. Chemical treatments typically provide protection for two years and should only be applied during outbreak periods. During outbreaks tree mortality rates become very high and management techniques become less effective. During these times trees with special value—in most cases a high-value tree is one in a private land owner's yard for which they have a personal attachment—can be chemically treated to help ensure that they survive the outbreak. At NWSE high-value trees may be located near administrative buildings or residences.

Preferred Alternative

I recommend Alternative 3, thinning and suppression. This alternative is both pro-active and responsive in nature. With the information gathered in the forest inventory that NWSE commissioned and the

analysis done in this report, NWSE is in the perfect position to plan forest management activities that will not only reduce insect damage, but also will help to meet other management objectives, most importantly wildfire hazard reduction. Although there may be many obstacles to overcome in order to put tree harvesting operations into place, thinning of pine stands is a management activity that has many benefits that include increased individual tree growth and vigor, reduction in tree losses due to insects, and reduction in fire hazard.

Active suppression activities should also be put into place and require some type of monitoring. Regular monitoring is important so that new SPB activity can be detected and suppression activities put into action prior to outbreaks becoming large and harder to manage. New Jersey Department of Environmental Protection performs annual aerial surveys to detect SPB-caused pine mortality. Although these data are usually not available online until the following spring, it is likely that NJDEP employees would be more than happy to share information on any SPB activity found on or near NWSE soon after surveys, if NWSE reached out to them with this request. Also, because of the road system at NWSE is so extensive, road side surveys would likely pick up most new activity. Unmanned aerial systems (UAS) may also be available. This is an ideal application for this technology and I am assuming that since this is a federal military base that UAS technology would be available. Typically, monitoring is looking for a specific change in crown color that can be detected from a distance, often referred to as a fader. Once faders are detected trees can then be visited and inspected for pitch-tubes and other signs of SPB activity. When faders are detected cut-and-remove, cut-and-leave, or other suppression activities can be performed.

With this two pronged management plan, the chances of NWSE experiencing high, unacceptable tree mortality would be very low. In fact, because the surrounding landscape is not made up of high SPB hazard forests, the chances of a situation in which extremely large SPB populations build up off of NWSE and spill onto the station are low. You may, however, experience a SPB outbreak in which many SPB spots develop at the same time and beetle populations grow rapidly. If this occurs you will have to prioritize the placement of your suppression activities. In this case, spots with large numbers of freshly attacked trees in high hazard stands should be prioritized for treatment (Clarke 2012). Also, the spot assessment system created by Billings and Pase (1979) should be utilized to help assess which spots to treat. Hopefully, with pro-active SPB management and prompt suppression you will be able to avoid large areas of pine mortality.

The U.S. Forest Service, Morgantown Field Office will be available to help assist you and enable SPB management activities, whatever alternative NWSE may select, and we hope to continue to trap SPB on NWSE to assist in our efforts to estimate state-wide SPB trends from year to year.

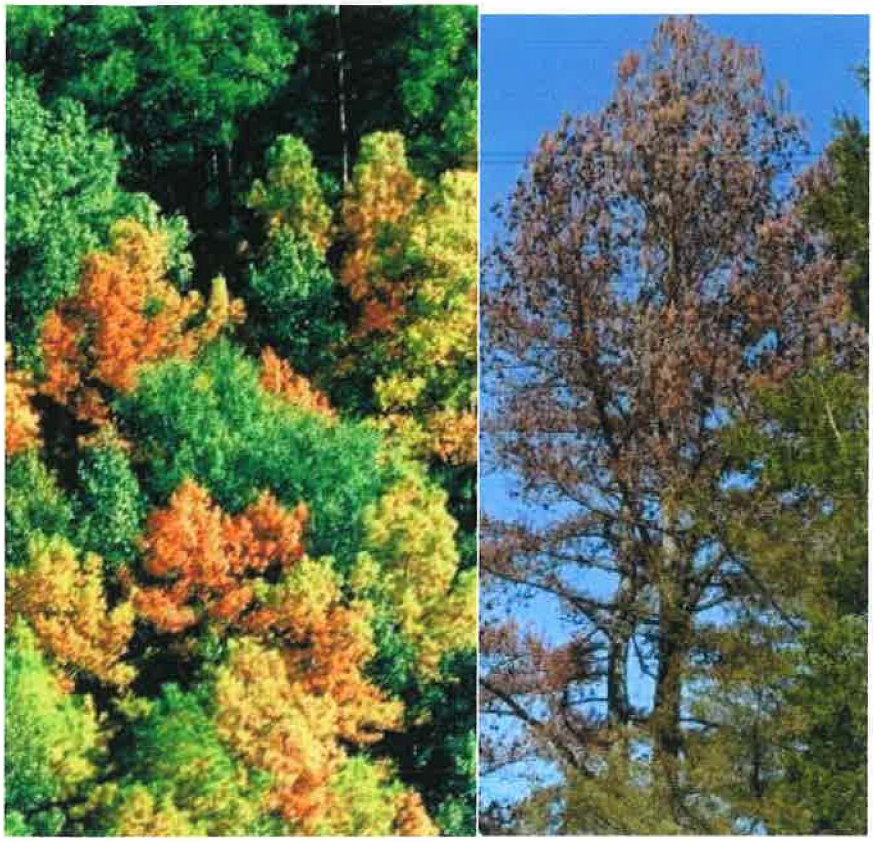

Figure 9. SPB-attacked trees experience crown fading that starts with a change from green to yellowish to red and finally an almost rust color once the tree is completely dead.

References

Brit, A. 2011. Risk assessment for the southern pine beetle. In: Coulson, R. and K.D. Klepzig *eds.* Southern Pine Beetle II. Ashville, NC: US Department of Agriculture Forest Service, Southern Research Station. 512 p.

Belanger, R.P., and B.F. Malac. 1980. Southern pine beetle handbook: silviculture can reduce losses from the southern pine beetle. Agric. Handb. 576. Washington, D.C.: U.S. Department of Agriculture, Combined Forest Pest Research and Development Program. 17 p.

Belanger, R.P., Hedden, R.L., Lorio, P.L. 1993. Managemnet strategies to reduce losses from the southern pine beetle. Southern Journal of Applied Forestry. 17(3): 150-154.

Billings, R.F, and H.A. Pase. 1979. A field guide for ground checking southern pine beetle spots. Agric. Handb. 558. Washington D.C.: U.S. Department of Agriculture. 19 p.

Burkhart, H.E., Haney, H.L., Newberry, J.D., Leuschner, W.A., et al. 1986. Evaluation of thinning for reduction of losses from southern pine beetle attack in loblolly pine stands. Southern J. of Applied Forestry. 10: 105-108.

Clarke, S.R. 2012. Implications of population phases on the integrated pest management of the southern pine beetle, *Dendroctonus frontalis*. J. Integ. Pest Mngmt. 3(1): 1-7.

Clarke, S. R., and J. T. Nowak. 2009. The southern pine beetle. U.S. Department of Agriculture Forest Service, Forest Insect & Disease Leaflet 49: 1–8.

Coster, J.E., and J.L. Searcy *eds*. 1981. Site, stand, and host characteristics of southern pine beetle infestations. USDA Comb. For. Pest. R&D Prog. Tech. Bull. 1612. 115 p.

Daniels, R.F., Leuschner, W.A., Zarnoch, S.J., Burkhart, H.E. et al. 1979. A method for estimating the probability of southern pine beetle outbreaks. Forest Science. 25(2): 265-269.

Garra, R.I., and J.E. Coster. 1968. Studies on the attack behavior of the southern pine beetle. III. Sequence of tree infestation within stands. Contrib. Boyce Thompson Inst. 24: 77-85.

Hedden, R.L. 1978. The need for intensive forest management to reduce southern pine beetle activity in East Texas. Southern J. of Applied Forestry. 2(1): 19-22.

Hedden, R.L. 1983. Evaluation of loblolly pine thinning regimes for reduction of losses from southern pine beetle attack. P. 371-375 *in* Proc. 2nd bienn. south. silvic. res. conf. Jones, E.P. *ed*. USDA For. Serv. Gen. Tech. Rep. SE-24.

Hedden, R.L., and R.P. Belanger. 1985. Predicting susceptibility to southern pine beetle attack in the coastal plane, Piedmont, and southern Appalachians. In: Branham, S.J., Thatcher, R.C., *eds*. Integrated pest management research symposium: the proceedings. Gen. Tech. Rep. S0-56. New Orleans, LA: U.S. Department of Agriculture Forest Service, Southern Forest Experiment Station: pp. 233-238.

Klepzig, K.D., Paschke, J., Nettleton, W., Anderson, R., 2003. Thinning and southern pine beetle. Forest Health Note, U.S. Department of Agriculture, Forest Service, Washington, DC, 2 pp.

Ku, T.T., Sweeney, J.M., and V.B. Shelbume. 1980. Hazard rating of stands for southern pine beetle attack in Arkansas. In: Hedden, R., Barras, S.J., Coster, J.E., *eds*. Hazard rating systems in forest insect pest management: symposium proceedings. Gen. Tech. Rep. W0-27. Athens, GA: U.S. Department of Agriculture Forest Service; pp 145-148.

Leuschner, W.A. 1980. Impact of the southern pine beetle. In: R.C. Thatcher, J.L. Searcy, J.E. Coster, and G.D. Hertel, *Eds*. The southern pine beetle. Tech. Bull. 1631. U.S. Department of Agriculture, Forest Service. p. 137-151.

McHugh, C.W., Kolb, T.E., and J.L. Wilson. 2003. Bark beetle attacks on ponderosa pine following fire in Northern Arizona. Environ. Entomol. 32(3): 510-522.

Swain, K.M., and M.C. Remion. 1981. Southern pine beetle handbook: direct control methods for the southern pine beetle. Agric. Handbook 575. U.S. Department of Agriculture, Forest Service. 15 p.

Swaine, J.M. 1925. The factors determining the distribution of North-American bark beetles. Can. Entomol. 58: 261–267.

Thatcher, R.C. 1960. Bark beetles affecting southern pines: a review of current knowledge. Occas. Pap. 180. Pineville, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 25 p.

Ungerer, M.J., M.P. Ayres, and M.J. Lombardero. 1999. Climate and the northern distribution limits of *Dendroctonus frontalis* Zimmerman (Coleoptera: Scolytidae). J Biogeogr, 26 (1999), pp. 1133–1145.

Appendix A.

Pine-dominated stands that should be considered for thinning treatments to decrease SPB hazard.

Compartment	Stand Number	Stand Size (ac)	Forest Description	% Pine	Trees per acre	Basal Area (ft^2/ac)	Mean DBH (in)	SPB Hazard
1	12	17	plantation pine	87	339	155	9	Medium
1	19	11	plantation pine	78	81	135	13	High
1	28	15	pine hardwoods	76	305	145	9	High
2	2	8	bottomland mixed	77	409	265	10	High
2	5	23	pine	71	201	160	12	High
2	6	17	pitch pine (pure)	89	197	140	11	High
2	10	7	pitch pine (pure)	85	220	130	10	High
2	13	28	xeric mixed pine-hardwoods	85	209	130	10	High
2	16	24	pitch pine (pure)	80	198	137	11	High
3	22	39	pitch pine (pure)	89	272	127	9	High
4	11	40	xeric mixed southern pine	74	349	153	9	Medium
4	12	32	xeric mixed pine-hardwoods	61	248	137	10	High
5	7	17	pitch pine (pure)	97	259	155	10	High
5	10	105	xeric mixed pine-hardwoods	63	184	128	11	High
5	14	21	oak northern pine	71	243	190	12	High
6	14	11	oak northern pine	92	193	125	10	High
6	18	26	pine	78	187	153	12	High
8	19	10	pitch pine (pure)	80	238	150	10	High

Compartment	Stand Number	Stand Size (ac)	Forest Description	% Pine	Trees per acre	Basal Area (ft^2/ac)	Mean DBH (in)	SPB Hazard
9	3	32	xeric mixed pine-hardwoods	72	243	153	10	High
9	13	22	xeric mixed southern pine	53	227	150	11	High
9	20	49	pine hardwoods	71	333	150	9	Medium
9	23	25	xeric mixed pine-hardwoods	65	226	123	10	High
9	24	30	xeric mixed southern pine	70	322	147	9	Medium

Appendix B.

Stand conditions and SPB hazard results for all stands at NWSE.

Comp	Stand	Stand area (ac)	% Pine	Trees per ac	Basal Area (ft^2/ac)	Average DBH (in)	SPB Rating
1	1	52.2	3	153	103	10.5	Low
1	2	36	9	151	107	10.9	Low
1	3	50.8	9	190	73	7.9	Low
1	4	60.8	0	125	100	11.3	Low
1	5	29.8	19	187	90	8.7	Medium
1	6	29.1	0	84	67	11.5	Low
1	8	17.9	4	199	140	10.4	Low
1	9	23.5	0	286	83	7.1	Low
1	10	20.7	21	161	95	9.8	Medium
1	11	9.4	71	143	70	9.0	Medium
1	12	16.9	87	339	155	8.9	Medium
1	13	41.4	25	158	93	10.0	Medium
1	14	26.4	0	209	113	9.3	Low
1	15	13.2	23	194	65	7.3	Low
1	16	11	18	272	110	8.0	Medium
1	17	84.1	16	179	108	9.6	Medium
1	18	32.7	5	66	67	13.3	Low
1	19	11.1	78	81	135	13.2	High
1	20	10.2	11	186	90	9.1	Medium
1	21	90.2	0	115	93	11.5	Low
1	22	26.3	2	61	160	8.3	Low
1	23	53	12	237	125	9.5	High
1	24	8.1	100	176	75	8.7	Low
1	25	10	37	218	135	9.7	Medium
1	26	95.8	30	123	83	10.5	Medium
1	27	21.3	21	210	97	8.7	Medium
1	28	14.7	76	305	145	8.9	High
2	1	16	0	253	155	10.1	Low
2	2	7.8	77	409	265	10.0	High
2	3	13.2	5	102	95	12.3	Low
2	4	2.9	0	593	260	8.5	Low
2	5	22.7	71	201	160	11.5	High
2	6	16.7	89	197	140	11.1	High
2	7	28.9	0	189	105	9.7	Low
2	8	25.7	0	132	83	10.0	Low

Comp	Stand	Stand area (ac)	% Pine	Trees per ac	Basal Area (ft^2/ac)	Average DBH (in)	SPB Rating
2	9	17.8	86	77	70	12.8	Medium
2	10	7	85	220	130	9.8	High
2	11	66.5	26	187	88	8.7	Medium
2	12	89.8	57	141	92	10.4	Medium
2	13	28	85	209	130	10.2	High
2	14	12.1	30	185	100	9.7	Medium
2	15	69.8	8	168	93	9.3	Low
2	16	23.9	80	198	137	10.6	High
2	17	23.7	0	186	103	9.7	Low
2	18	58.6	79	167	113	10.5	Medium
2	19	26.6	20	137	75	9.4	Low
2	20	27.2	67	46	15	7.1	Medium
2	21	36.1	55	160	97	9.8	Medium
2	22	22.2	8	99	87	12.1	Low
2	23	2.3	0	609	190	7.4	Low
3	1	23.8	0	148	117	11.3	Low
3	2	17.3	0	133	80	9.7	Low
3	3	15.8	18	224	140	9.8	Medium
3	5	10.3	20	105	50	8.3	Medium
3	6	19.8	29	100	85	12.0	Medium
3	7	10.6	0	157	115	10.9	Low
3	8	10.2	0	121	110	11.6	Low
3	9	21.4	20	158	117	10.7	Medium
3	10	39.5	0	291	200	10.6	Low
3	11	43	11	103	90	12.0	Medium
3	13	40.8	0	123	53	8.4	Low
3	14	20.2	100	116	50	8.6	Low
3	15	24.9	4	108	87	11.1	Low
3	17	71.3	0	80	38	8.8	Low
3	18	44.1	71	153	70	8.7	Medium
3	19	40.1	26	127	63	9.1	Low
3	20	28.1	83	207	97	8.8	Medium
3	21	27.5	52	172	70	8.3	Low
3	22	38.9	89	272	127	8.9	High
3	23	56.7	33	246	105	8.4	Low
3	24	27.2	94	223	103	8.8	Medium
3	25	14.3	45	233	110	8.9	Medium
3	26	36.5	45	149	73	9.3	Low

Comp	Stand	Stand area (ac)	% Pine	Trees per ac	Basal Area (ft^2/ac)	Average DBH (in)	SPB Rating
3	27	111.6	86	185	110	10.0	Medium
3	29	21.8	55	212	97	8.6	Medium
4	1	20.9	28	135	90	10.2	Medium
4	2	67.1	0	100	77	11.4	Low
4	3	23.6	11	209	123	9.8	High
4	4	10.5	40	94	50	9.0	Low
4	5	69.4	0	123	67	9.5	Low
4	6	30.7	43	201	93	8.7	Medium
4	7	15.6	9	227	115	9.3	Low
4	8	26.1	14	173	73	8.5	Low
4	9	30.7	40	292	117	8.1	Low
4	10	43.1	9	118	77	10.6	Low
4	11	40	74	349	153	8.6	Medium
4	12	31.6	61	248	137	9.7	High
4	13	21.2	3	176	97	9.8	Low
4	14	41	77	136	73	9.2	Medium
5	1	12.2	44	151	90	10.3	Medium
5	2	17	0	75	35	9.1	Low
5	3	31.9	61	206	110	9.3	Medium
5	4	75.7	15	293	100	7.6	Medium
5	6	47.4	77	146	103	10.9	Medium
5	7	17.1	97	259	155	10.0	High
5	8	72.8	34	183	97	9.3	Medium
5	9	36	65	78	77	12.9	Medium
5	10	104.6	63	184	128	10.9	High
5	12	22.1	24	116	97	11.7	Medium
5	13	69.8	19	124	105	12.0	Medium
5	14	21.1	71	243	190	11.7	High
6	1	76.6	13	109	100	12.6	Medium
6	2	71.3	93	153	97	10.1	Medium
6	3	15.3	41	145	110	11.0	Medium
6	4	70.4	93	153	90	9.9	Medium
6	5	37.6	50	222	87	8.2	Low
6	6	57.6	61	117	93	11.8	Medium
6	7	81.6	37	117	68	10.0	Low
6	8	112.4	54	145	120	11.9	Medium
6	9	138.7	72	191	94	8.9	Medium
6	10	64.9	22	147	90	10.3	Medium

Comp	Stand	Stand area (ac)	% Pine	Trees per ac	Basal Area (ft^2/ac)	Average DBH (in)	SPB Rating
6	12	159.6	74	171	120	10.8	Medium
6	13	39.7	4	181	83	8.9	Low
6	14	11.1	92	193	125	10.3	High
6	15	42.2	17	107	60	9.8	Low
6	16	88.9	33	132	90	10.8	Medium
6	17	149.8	34	106	78	11.3	Low
6	18	25.6	78	187	153	11.7	High
7	1	14.3	0	77	100	13.7	Low
7	2	99.5	1	171	137	11.1	Low
7	3	29.1	0	146	127	11.8	Low
7	4	10.3	0	107	75	10.4	Low
7	5	104.9	3	121	62	9.1	Low
7	6	29.8	7	145	93	9.5	Low
7	7	31	25	266	120	8.4	Medium
7	8	8	0	454	273	10.1	Low
7	9	23.3	11	234	127	9.6	Medium
7	10	27.3	17	150	140	12.3	Medium
7	11	16.7	0	99	125	14.3	Low
7	13	34.7	4	190	170	12.1	Low
7	14	21.7	32	212	110	9.2	Medium
7	15	20.4	0	170	135	11.1	Low
7	16	79.9	5	182	116	10.4	Low
7	17	78.6	17	158	116	10.8	Medium
7	18	41.5	0	117	100	12.2	Low
7	19	68.4	76	129	93	11.1	Medium
7	21	67.3	58	154	78	9.2	Medium
7	23	15	100	213	80	8.0	Low
7	24	17	6	116	90	11.4	Low
7	25	53	24	189	110	9.8	Medium
7	26	46.1	45	362	127	9.0	Medium
7	27	31.8	84	186	103	9.5	Medium
8	1	21.5	0	77	93	14.2	Low
8	2	72.9	26	156	175	13.4	High
8	3	60.6	6	145	120	11.6	Low
8	4	29	10	94	70	10.8	Low
8	5	17.1	6	105	85	11.8	Low
8	6	26.8	22	185	120	9.9	Medium
8	7	23.6	19	137	103	10.7	Medium

Comp	Stand	Stand area (ac)	% Pine	Trees per ac	Basal Area (ft^2/ac)	Average DBH (in)	SPB Rating
8	8	31	53	168	105	10.3	Medium
8	9	58.9	13	178	130	10.9	High
8	10	68.1	32	132	103	10.6	Medium
8	11	73.7	28	185	118	10.2	Medium
8	12	60.9	38	122	107	11.7	Medium
8	13	47	0	153	93	9.9	Low
8	14	32.6	12	198	108	9.2	Medium
8	15	21.6	67	162	90	9.4	Medium
8	16	48.2	12	102	87	11.6	Medium
8	17	87.8	88	150	97	10.3	Medium
8	18	26.3	0	55	63	14.4	Low
8	19	10	80	238	150	10.3	High
8	20	35.6	35	106	77	10.9	Low
8	21	15.8	65	141	85	9.9	Medium
8	22	28.3	60	151	83	9.8	Medium
8	23	6.2	100	77	100	15.4	Medium
8	24	21.9	4	128	83	10.6	Low
8	25	50.5	50	210	107	9.0	Medium
8	26	12.8	0	171	85	9.0	Low
8	27	29.2	12	180	113	10.2	Medium
9	1	23.9	92	79	43	9.6	Medium
9	2	24.1	0	120	100	11.7	Low
9	3	32.3	72	243	153	10.2	High
9	4	53.4	33	184	130	10.9	Medium
9	5	79.5	24	160	93	9.5	Medium
9	6	27	100	170	70	8.6	Low
9	8	6.6	67	303	90	7.2	Medium
9	9	48.2	5	166	123	11.1	Low
9	10	41.5	0	131	107	11.8	Low
9	11	41.4	50	242	120	9.0	Medium
9	12	78.6	14	174	108	10.1	Medium
9	13	21.5	53	227	150	10.5	High
9	14	111	11	150	105	10.6	Medium
9	15	16.5	100	291	80	6.9	Low
9	16	43.4	4	216	115	9.5	Low
9	17	22	0	171	97	9.6	Low
9	18	63.3	10	162	104	10.2	Medium
9	19	35.5	48	139	77	9.7	Low

Comp	Stand	Stand area (ac)	% Pine	Trees per ac	Basal Area (ft^2/ac)	Average DBH (in)	SPB Rating
9	20	49.2	71	333	150	8.7	Medium
9	21	57	9	205	107	9.2	Low
9	23	25.2	65	226	123	9.7	High
9	24	30.3	70	322	147	8.8	Medium
		39	34	176	105	10	

Forest Service

Northeastern Area
State and Private Forestry

180 Canfield Street
Morgantown, WV 26505-3101

File Code: 3420
Date: January 10, 2017

Captain J.M. Steingold
U.S. Naval Commanding Officer
Naval Weapons Station Earle
201 Hwy 34
Colts Neck, New Jersey 07722-5001

Dear Capt. Steingold:

Enclosed is the 2017 biological evaluation for southern pine beetle (SPB) at Naval Weapons Station Earle (NWSE). During the summer 2016, Patricia Chizmadia, of NWSE Environmental Division joined Forest Health Protection personnel from the U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry Field Office in Morgantown, WV, at NWSE to conduct a survey to detect southern pine beetle, *Dendroctonus frontalis*.

The purpose of the survey was to see if SPB is present and contributing to tree mortality, and determine the need for management activities within the site. During our visit, NWSE agreed to allow U.S. Forest Service entomologists to use recently obtained forest inventory data to perform a SPB hazard analysis to help inform management recommendations. Since we found SPB galleries within the suspected area of SPB-caused mortality and SPB has been found in traps at NWSE, we recommend that NWSE develop and implement a SPB management plan that includes silvicultural treatments (e.g., thinning of high density, pine dominated forest stands) and SPB suppression treatments (e.g., cut-and-remove, cut-and-leave).

We will continue to help NWSE monitor the extent and severity of this infestation and will provide treatment and management assistance. NWSE personnel can assist in these efforts through continued pheromone-baited trapping and monitoring for evidence of SPB activity, including crown discoloration, pitch-tubes, and pine mortality and reporting any insect and disease activity to the Morgantown Field Office.

If you or any of your staff have any questions or comments regarding this survey, please contact either Chris Hayes at (304) 285-1553 or Rick Turcotte at (304) 285-1503.

Sincerely,

Robert Lueckel

ROBERT LUECKEL
Field Representative

Enclosures:

cc: Patricia Chizmadia, Natural Resources Specialist